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HOME AUTOMATION WITH ZIGBEE TECHNOLOGY

Abstract. *This article reviewed existing technologies in the field of home automation, presented the advantages of ZigBee technology, its description, as well as a description of the developed system and all its constituent elements.*

Keywords: *ZigBee, ZigBee network model, Home automation, Xbee, Arduino-uno.*

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АВТОМАТИЗАЦИЯ ДОМА С ПОМОЩЬЮ ТЕХНОЛОГИИ ZIGBEE

Аннотация. *В статье были рассмотрены существующие технологии в сфере автоматизации дома, представлены преимущества технологии ZigBee, ее описание, а также описание разработанной системы и всех ее составных элементов.*

Ключевые слова: *ZigBee, сетевая модель ZigBee, автоматизация дома, Xbee, Ардуино-уно.*

Introduction. It's no secret that a person's life is getting easier every day, thanks to various gadgets, household devices and so on. In the modern world, you can even control your home using your smartphone, which is in almost every pocket, although these technologies seemed fantastic a few decades ago. The automated system, which the «smart» home has become, frees a person from household chores. Thus, the time saved can be spent on what is really pleasant and useful. But you need to figure out what such a house is, as well as what are the advantages and disadvantages.

«Smart Home» is a special building management system that solves the problems of security, communication and entertainment. This system consists of such elements as switches, timers, sensors, various sensors that help to measure physical parameters. There are also auxiliary devices: power supplies, modules and interfaces. Such a system can be installed not only in large country houses, but also in an ordinary apartment.

Existing solutions and ZigBee advantages. Over the past decade, various progressive wireless communication standards have been developed and implemented. GSM, WiFi and Bluetooth are well known to most people in today's society. These are high-availability systems that ensure mutual compatibility between various electronic and power devices, as well as, using interactive interfaces, allow their operation to be controlled. These technologies make life easier for people. However, while they cover most wireless networking needs, they are not well suited for home automation. For this, ZigBee is best suited - a protocol for building wireless networks that do not require high data transfer rates, which was developed to connect a large number of autonomous devices into a network. An open standard for wireless communication, ZigBee enables self-organizing and self-healing wireless networks with automatic message relaying. In 2007, a standard for smart home control commands, the so-called «Home Automation» profile, appeared. Almost all devices for creating home automation are produced with ZigBee: relays, dimmers, lamps, thermostats, locks, sensors. Here are some more advantages of this technology:

1) Low cost
2) Open standards

3) Easy to deploy

4) Excellent performance outdoors, in the environment

5) Appropriate working range (30 - 100 m)

6) Reliable data transmission: 250 kbps (at 2.4 GHz)

7) Very low power consumption

8) Secure data transmission,

9) ZigBee protocol requires less than 64KB of ROM and 2 to 32KB of RAM

10) ZigBee network can be deployed with any type of microcontroller.

ZigBee network model. Devices within a ZigBee network can be divided into three types:

1) Coordinator: organizes the network and maintains routing tables,

2) Routers: they can communicate with the coordinator, with other routers and end devices with limited functions

3) End devices: They can communicate with routers and the coordinator, but not with each other.

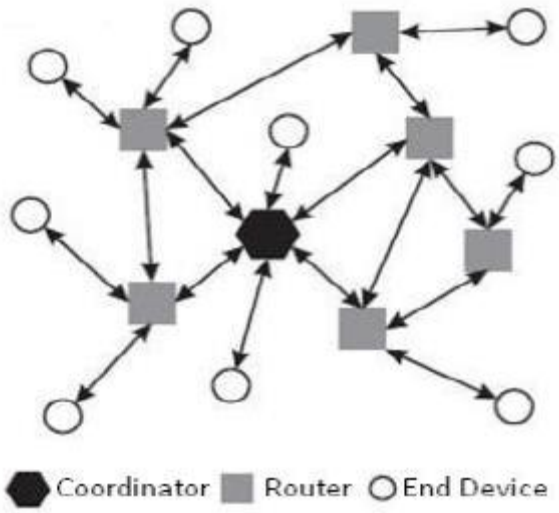

Fig. 1 – ZigBee network model

The coordinator and routers are defined as fully functional devices that are energized always when mains power is on. End devices are defined as devices with limited functionality. Sensors and actuators can be connected to each of these three ZigBee devices. Except for the conventional mesh topology, it is also possible to use a

tree or star topology, which requires fewer microcontroller hardware and software resources.

Frame protection and routing to end nodes is done at the network layer. Direct neighboring nodes are located here and information about them is stored. The network layer coordinator provides communication and distributes addresses to new connected devices. The MAC layer synchronizes the network, provides access to the radio channel, checks the validity of the frame, confirms the receipt of the frame, controls the connection, generates and recognizes addresses. The Application Support Sublayer takes care of the binding tables that allow you to map (bind) devices according to the services they provide. Communication between devices depends on the ZigBee Profile, which is a summary of device properties and defining message formatting so that devices can create practical applications.

Home automation with ZigBee. Figure 2 shows a functional scheme of a home automation system with an indication of individual elements:

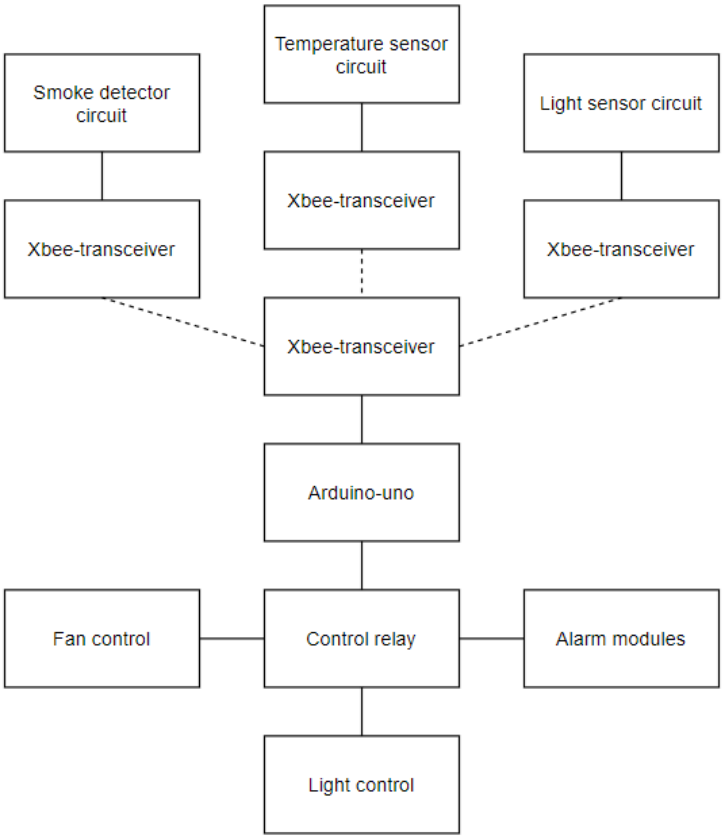

Fig. 2. Functional scheme of the system

When the sensor detects smoke or fire, the ZigBee transmitter will send these signals to the ZigBee receiver. The controller unit activates the alarm circuit when a fire or smoke is detected in the house.

A variety of smoke detectors are available on the market based on different physical phenomena. The smoke sensor can be realized with an optocoupler sensor. An optocoupler is an electronic device consisting of a light emitter (usually an LED, in early products - a miniature incandescent lamp) and a photodetector (bipolar and field-effect phototransistors, photodiodes, photothyristors, photoresistors) connected by an optical channel and, as a rule, combined in a common housing. The principle of operation of an optocoupler is to convert an electrical signal into light, transmit it through an optical channel and then convert it back into an electrical signal. This smoke detector can be directly used to detect smoke or fire.

• Temperature sensor network

The temperature sensor will detect the temperature in the room or house, and if the temperature rises above the nominal value, then these signals are received to the controller unit through the receiver, and the relay is activated, so the fans / air conditioner are turned on, and when the temperature drops below the set value, the opposite action will occur temperature and the fans / air conditioner will turn off.

There are various types of temperature sensors available on the market. In our case, the LM358 is suitable - a widely used temperature sensor that has a range of -55 ° to + 150 ° C. The output voltage of the LM358 is linearly proportional to the temperature on the Celsius scale. Thus, the LM35 has, for example, an advantage over Kelvin calibrated linear temperature sensors, as the user does not need to subtract a large DC voltage from its output signal to obtain convenient Celsius scaling. The LM35's low output impedance, linear output and accurate internal calibration make connecting to sensing or control circuits particularly easy.

• Light sensor

A light sensor is required to turn on the lights in the house. As such, we will use a simple LDR - photoresistor. A photoresistor is a resistor whose resistance decreases as the intensity of the incident light increases. It is made of high resistance

semiconductor. If the light striking the device has a high enough frequency, the photons absorbed by the semiconductor give the bound electrons enough energy to jump into the conduction band. The resulting free electron conducts electricity, thereby reducing resistance. The photovoltaic device can be internal or external. LDR is an economical light sensor that can be implemented in a home automation sensor network.

• Xbee module

This module is primarily responsible for working with external sensors that provide parameter values in the form of analog voltage or have outputs with two states - "on / off". The XBee module has analog and digital ports. Also, the XBee module is directly interfaced with any devices that have a UART interface. When working independently, the XBee-module can transmit data according to a given schedule, sending it at regular intervals, or by changing the signal state on a digital port.

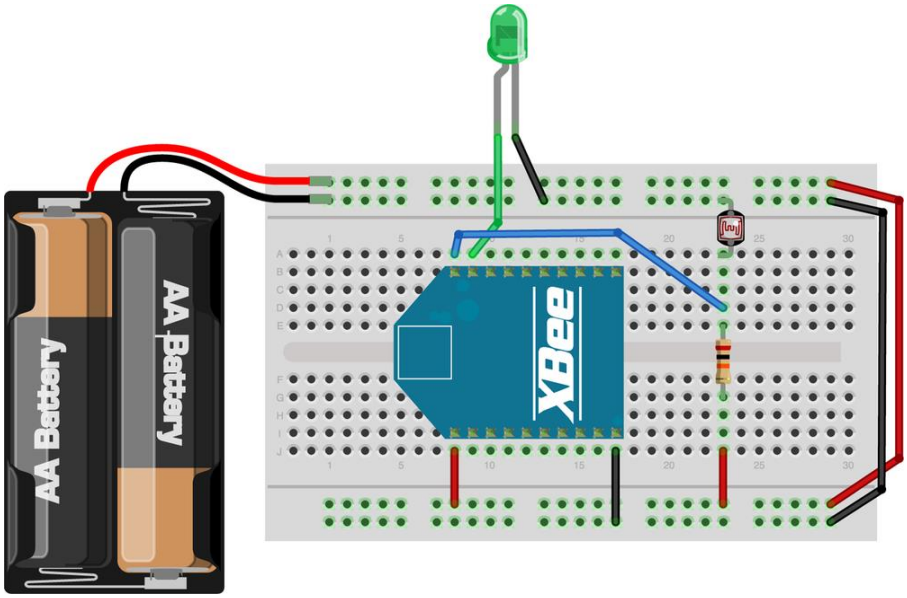

Fig. 3. An example of connecting an Xbee module with different sensors and power supply

• Network coordinator

As the coordinator of the ZigBee network, it is proposed to use a bundle of the Arduino-Uno board and the Xbee module to implement a wireless home automation sensor network for work control. Other members of the Arduino family can also be used depending on the use and complexity of the automation network. The signals

received from the network routers are processed by the coordinator and transmitted to the circuit with the control relay.

Conclusion. This article shows a developed home automation system using ZigBee technology. Thanks to its use, we can eliminate the difficulties with the connection in the case of wired automation. ZigBee also offers a much wider operating range than Bluetooth. Significant energy savings are possible using the above circuit, it is flexible and will be compatible with future technologies, so it can be easily customized to suit individual requirements.

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